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NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA

ICS 25.200

J 36

GB/T 34889-2017

**Carburizing or carbonitriding,
quenching and tempering of steel parts**

钢件的渗碳与碳氮共渗淬火回火

Issued on: November 01, 2017

Implemented on: May 01, 2018

**Issued by: General Administration of Quality Supervision, Inspection and
Quarantine of the People's Republic of China;**

**Standardization Administration of the People's Republic of
China.**

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Carburizing or carbonitriding, quenching and tempering of steel parts

1 Scope

This Standard specifies the technical requirements and methods for carburizing or carbonitriding, quenching and tempering of steel parts.

This Standard is applicable to carburizing or carbonitriding, quenching and tempering of steel parts, and is not applicable to iron castings and powder metallurgy parts.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 224 Determination of depth of decarburization of steels

GB/T 230.1 Metallic materials - Rockwell hardness test - Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

GB/T 699 Quality carbon structure steels

GB/T 700 Carbon structural steels

GB/T 1182 Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out

GB/T 3077 Alloy structure steels

GB/T 4340.1 Metallic materials - Vickers hardness test - Part 1: Test method

GB/T 4341.1 Metallic materials - Shore hardness test - Part 1: Test method

GB/T 5216 Structural steel with specified hardenability bands

GB/T 6394 Determination of estimating the average grain size of metal

GB/T 7232 Terminology of metal heat treatment

GB/T 8121 The terminology of technological materials of heat treatment

GB/T 9450 Steels - Determination and verification of the depth of carburized and hardened cases

GB/T 9452 Testing method for working zone of heat treatment furnace

GB/T 10201 Regulations of proper usage of electricity in heat treatment industry

GB/T 12603 Classifications and designations for metal heat treatment

GB/T 13324 Terminology of heat treatment equipment

GB 15735 Requirements for the safety and health in production process of metal heat treatment

GB/T 15822.1 Non-destructive testing - Magnetic particle testing - Part 1: General principles

GB/T 16923 Normalizing and annealing of steel parts

GB/T 16924 Quenching and tempering of steel parts

GB/T 17358 Power consumption, measurement, and testing in heat treating production

GB/Z 18718 Energy saving directives for heat treatment

GB/T 18851.1 Non-destructive testing - Penetrant testing - Part 1: General principles

GB/T 19944 Fuel consumption calculation and measurement method in heat treating production

GB/T 21736 Technical specifications of energy-saving combustion devices for heat treating

GB/T 22561 Vacuum heat treatment

GB/T 25744 Metallographic examination for carburizing quenching and tempering of steel parts

GB/T 27945.1 The management of hazardous solid wastes from heat treatment salt - Part 1: General management

GB/T 27945.2 The management of hazardous solid wastes from heat treatment salts - Part 2: Test method of extractives

GB/T 27945.3 The management of hazardous solid wastes from heat treatment salts - Part 3: Method of innocent treatment

GB/T 30822 Environmental protection technical requirements for heat treatment industry

GB/T 30825 Pyrometry for heat treatment

GB/T 32541 Quality control system for heat treatment

JB/T 6050 Generalization of hardness test for heat treated iron and steel parts

JB/T 7530 General technical requirements for argon, nitrogen and hydrogen gases used in heat treatment

JB/T 9209 Technical requirement of medium for thermo-chemical treatment

JB/T 9218 Non-destructive testing - Test method for penetrant testing

JB/T 10312 Steel-foil method for determination of carbon-potential of carburizing atmospheres

JB/T 11078 Vacuum carburizing and post-quenching of steel part

JB/T 11809 Technical requirement of heat treatment for vacuum low pressure carburizing furnace

SH/T 0553 Industrial propane, butane

3 Terms and definitions

For the purpose of this document, the terms and conditions defined in GB/T 7232, GB/T 8121, GB/T 13324, GB/T 9452, GB/T 16923, GB/T 32541 and the following apply.

4 Process classification and code

The process classification and code of carburizing and carbonitriding of steel parts are in accordance with the provisions of GB/T 12603, and the specific classification and code are shown in Table 1.

material gas is required to be stable, the gas atmosphere and carbon potential shall be adjustable, and harmful impurities shall be less; the agent inlet shall be not easily blocked. When the hot cracking gas of the organic liquid is used as the raw material gas, it shall have less harmful impurities, be easy to crack, and have good fluidity; the agent shall meet the requirements of JB/T 9209 and SH/T 0553.

6.1.3 The vacuum carburizing equipment and vacuum carbonitriding equipment shall meet the technical requirements specified in GB/T 22561 and JB/T 11809.

6.1.4 The ion carburizing equipment and ion carbonitriding equipment shall be equipped with overheat protection device and arc discharge protection device, which can adjust the vacuum degree and atmosphere to suit the processing needs and can maintain stable glow discharge. To adjust the proportion of gas, a gas flow meter shall be equipped.

6.1.5 The salt bath liquid carburizing or carbonitriding equipment shall not cause corrosion or other harmful effects on the workpiece and the environment. The salt attached to the workpiece shall be able to be removed. The salt bath is required to have a small viscosity and evaporation amount within the operating temperature range. The management and treatment of the salt bath solid waste shall meet the requirements of GB/T 30822 and GB/T 27945.1, GB/T 27945.2 and GB/T 27945.3.

6.1.6 The running speed of the workpiece in the continuous carburizing or carbonitriding equipment shall be adjustable, so that the heating, holding and cooling temperature and the holding time in each area shall meet the requirements of the process.

6.2 Quenching heating equipment

6.2.1 According to the workpiece type and process requirements, reasonably select the quenching heating equipment, which shall meet the relevant requirements of GB/T 32541. The effective heating zone shall be measured according to the method of GB/T 9452, and the temperature uniformity shall be controlled within $\pm 10^{\circ}\text{C}$.

6.2.2 The composition of the furnace gas of the controllable atmosphere quenching heating equipment shall meet the requirements of the quenching process and shall be adjustable. The argon, nitrogen and hydrogen used in the protective atmosphere heating equipment shall comply with the requirements of JB/T 7530.

6.2.3 The flame of the fuel heating equipment shall not be in direct contact with the workpiece.

6.4 Tempering heating equipment

According to the workpiece type, reasonably select the tempering heating equipment. The effective heating zone shall be measured according to the method of GB/T 9452, and the temperature uniformity shall be controlled within $\pm 10^{\circ}\text{C}$. Other requirements are as specified in 6.2.2 ~ 6.2.5.

6.5 Temperature measurement and control device

Each heating zone of the heating equipment shall be equipped with temperature measurement and temperature control automatic recording equipment, and shall comply with the provisions of GB/T 30825 and GB/T 32541.

6.6 Carbon potential measurement and control

The carbon potential measurement and control shall comply with the provisions of GB/T 32541 and JB/T 10312. The oxygen potential shall be measured and controlled using an oxygen probe and a carbon potential meter.

6.7 Maintenance of equipment

It shall prepare appropriate equipment operating procedures and maintenance systems to maintain the normal performance of the equipment. It shall keep relevant records in good condition.

7 Carburizing or carbonitriding, quenching and tempering process and operating procedures

According to the characteristics of the workpiece to be processed (material, status before processing and specifications), processing equipment used, carburizing agent, carbonitriding agent, furnace loading requirements, heating and cooling conditions, and whether subsequent processing is carried out, etc. follow the following provisions and make reasonable heat treatment process and operating procedures before operating.

7.1 Preparation before processing

7.1.1 Technical conditions of the workpiece to be processed

The layer surface hardness, the layer core hardness, the layer depth, the layer structure, the core structure, and the distortion of the workpiece to be processed shall all comply with the characteristics of the process of carburizing and carbonitriding, quenching and tempering. The process specifications are formulated according to the quality requirements of the workpiece to be

liquid carburizing, liquid carbonitriding shall be preheated. Vacuum carburizing is carried out in accordance with the provisions of JB/T 11078.

7.2.4.4 After carburizing, if it is necessary to cool before quenching, the appropriate cooling rate shall be used to make the temperature of each part of the surface of the workpiece uniform. At the same time, it shall take measures to avoid oxidation, decarburization and corrosion of the surface of the workpiece.

7.2.5 Sample

The material grade, chemical composition and processing conditions of the sample shall be the same as the workpiece; the size and form of the sample shall reflect the characteristics of the workpiece, and the position of the sample shall be representative. The sample can be divided into the furnace sample and the process sample. The furnace sample is inspected after the workpiece is processed to determine whether the microstructure and hardened layer of the workpiece after carburizing or carbonitriding meet the requirements; the process sample can be used to determine whether the process is normal during carburizing or carbonitriding.

Periodic sampling inspection shall be carried out during the production process of periodic furnace. Samples shall be verified during the production of continuous furnace.

7.3 Quenching

7.3.1 When quenching, the surface of the workpiece shall not be decarburized, and the heating temperature and holding time shall meet the technical requirements.

7.3.2 The temperature of the workpiece at different positions in the furnace shall be uniform.

7.3.3 Adjust the quenching cooling medium to the use temperature range.

7.3.4 Select the correct heating and cooling method.

7.3.5 Other technical requirements shall comply with the provisions of GB/T 16924.

7.4 Tempering

7.4.1 The temperature of each part of the workpiece shall be consistent when heating.

7.4.2 After the workpiece is quenched, it shall be tempered in time, and the

evaluated according to the method of GB/T 25744. The grain size shall be evaluated according to the method of GB/T 6394. The surface decarburization shall be evaluated according to the method of GB/T 224. It shall also meet the requirements of the technical documentation of the workpieces approved by the relevant parties.

8.5 Distortion

Measure with appropriate instruments and gauges. The distortion of the workpiece shall not affect its subsequent machining and use. The specific distortion shall be determined by the entrusting and the entrusted parties.

9 Acceptance

At the time of acceptance, the inspection to the appearance, surface hardness, hardened layer depth, microstructure and distortion of the processed workpieces shall meet the requirements of Clause 8. The inspection of the hardened layer depth allows for the use of similar samples of the same material. The inspection of microstructure may be carried out by negotiation between the entrusting and the entrusted parties.

10 Safety and health and labor protection requirements

The safety and health and labor protection requirements for carburizing and carbonitriding, quenching and tempering shall comply with the relevant provisions of GB 15735.

11 Energy consumption and environmental protection requirements

The energy consumption of carburizing and carbonitriding, quenching and tempering process shall comply with the relevant provisions of GB/Z 18718, GB/T 21736, GB/T 10201, GB/T 17358 and GB/T 19944. The environmental protection technical requirements shall comply with the provisions of GB/T 30822.

12 Product report

The report shall include the following:

- name and figure number of the workpiece;

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